



## **NATIONAL TRANSPORTATION SAFETY BOARD**

Office of Aviation Safety  
Western Pacific Region

April 30, 2015

# **AIRFRAME / ENGINE EXAMINATION, AND MAINTENANCE RECORDS SUMMARY REPORT**

**WPR15FA121**

This document contains 16 embedded photos.

## **A. ACCIDENT**

Location:	Santa Monica, California
Date:	March 5, 2015
Aircraft:	Ryan Aeronautical ST-3KR, N53178
NTSB Investigator-in-Charge:	Albert P. Nixon

## **B. SUMMARY**

On March 5, 2015, about 1422 Pacific standard time, a Ryan Aeronautical ST-3KR, N53178, sustained substantial damage during a forced landing following a reported loss of engine power during takeoff initial climb from the Santa Monica Municipal Airport, Santa Monica, California. The airplane was registered to MG Aviation Inc., and operated by the pilot under the provisions of Title 14 Code of Federal Regulations Part 91. The private pilot, sole occupant of the airplane, was seriously injured. Visual meteorological conditions prevailed, and no flight plan was filed for the personal flight. The local flight originated from the Santa Monica Municipal Airport about 1421.

Examination of the recovered wreckage was conducted at a private hangar facility located at the Santa Monica Municipal Airport (SMO) on March 9 and 10, 2015. In addition, the magnetos and carburetor was examined on March 11, 2015. Further examination of the recovered airframe was conducted on April 9, 2015 at a private hangar facility at SMO.

## **C. DETAILS OF THE INVESTIGATION**

### **1.0 Airplane Information**

The Ryan aeronautical ST-3KR is a two-place tandem configured low wing monoplane, manufactured in 1942. Each seat (forward and aft) was originally equipped with a lap belt restraint system, installed to the seat structure. The area surrounding the lap belt attach point was reinforced by the installation of aluminum doublers. The airplane was not originally equipped with shoulder restraints for either seat.



Photo 1: Aft seat left side lap belt attach point.



Photo 2: Aft seat right side lap belt attach point.

## 2.0 Recovered Airframe Examination

Examination of the recovered airframe revealed that both the left and right wings were removed to facilitate wreckage recovery and subsequent transport.

The airframe fuel filter (gascolator) was removed and subsequently disassembled. The gascolator bowl was free of debris. A very slight amount of debris was observed on the gascolator screen. Multiple fuel line fittings were impact damaged, and separated from the gascolator.

The fuel selector valve handles (forward and aft) were found in the "off" position. The fuel selector valve remained attached and secure to the selector valve handle shaft. The fuel selector valve was removed and disassembled. Internal examination of the fuel selector valve revealed

that the valve was in the "off" position. When moved to both the main and reserve positions, air was applied to the inlet port, and no restrictions were noted.

The fuel tank remained intact, and the fuel tank cap was separated. Impact damage was observed surrounding the fuel cap. Internal examination of the fuel tank revealed that no debris or contaminants was present. No fuel was observed within the fuel tank. Compressed air was applied to the main and reserve outlet port fuel lines with no restrictions noted within the fuel lines. Compressed air was applied to the fuel vent line with no restrictions noted.

The aft seat remained attached to the airframe via its mounts. The lower right aft attach bracket was separated, and exhibited impact damage. The upper back portion of the seat was bent forward and downward. The seatback pan was wrinkled and distorted. The right side of the seatback was partially torn from the upper right corner extending downward at a 45-degree angle toward the middle of the seat back. The wooden seat structure on the front bottom side was splintered downward.



**Photo 3: Aft seat, side view.**



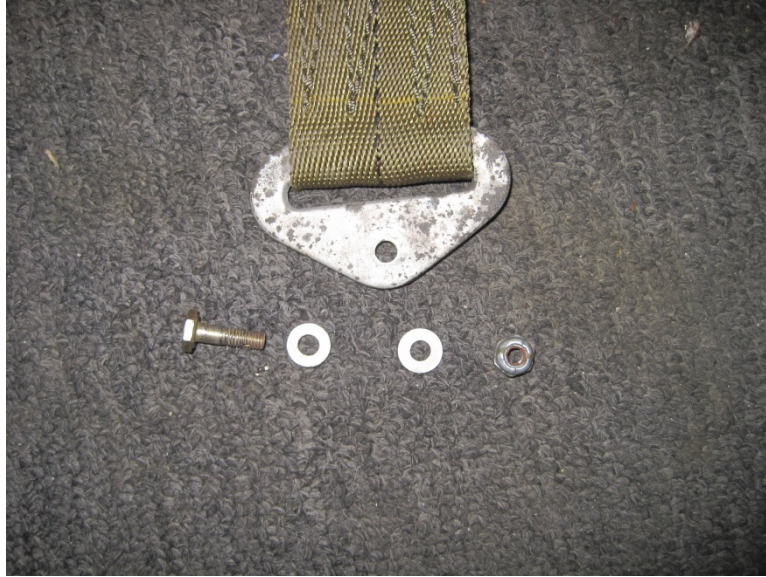
**Photo 4; Aft seat, rear view.**

The left and right seat belt restraints remained attached to their respective mounts and seat structure. The shoulder restraints were separated, however, the attach bolt remained intact and secure to the shoulder restraint harness. The shoulder harness restraint appeared to have been attached using an AN3-3 bolt, two AN-960 washers, and an AN365 elastic stop nut. A hole, similar to the size of the shoulder harness attach bolt, was observed on the back of the seat, about 2 and 3/8ths inch above the seat bottom. The aluminum structure of the seat back was peeled away (outward and upward) from the shoulder restraint bolt hole, consistent with the attach bolt being pulled through the metal structure. There was no evidence of installed reinforcement surrounding the shoulder restraint bolt hole and peeled away seatback structure.



**Photo 5: Aft seat, shoulder harness attach point.**





**Photo 6: Aft seat shoulder harness attach bracket and hardware.**

The shoulder harness was intact and undamaged, and was green in color. Only the markings "left" and "right" on the shoulder straps were present. No additional markings, data tags, or Technical Standard Order (TSO) numbers were observed on the shoulder restraints. Both the left and right lap belts were intact, undamaged, and were a different shade of green. No markings, data tags, or TSO numbers were observed.

The front seat was intact, and not removed. However, the shoulder restraint appeared to be installed in a similar fashion to the aft seat.



**Photo 7: Front seat shoulder restraint attachment.**

The upper portion of the aft cockpit structure, which was covered by leather material, was compressed forward, and displaced downward. The instrument panel structure was displaced forward.



**Photo 8: Aft seat dash and instrument panel.**

### **3.0 Recovered Engine Examination**

Examination of the recovered Kinner R-55 engine, serial number 07450, revealed that it remained attached to the airframe engine mount, and displaced downward at an approximate 45-degree angle. The starter was separated from the starter adapter, and the carburetor was displaced from its respective mounts. Impact damage was observed on the bottom side of the oil tank, and the outlet port was damaged and pulled away at the fitting, which resulted in a breach of the oil tank. When the engine was attached to an engine hoist, residual oil was observed draining from the oil tank outlet port. The oil shut off valve was found separated from the oil tank outlet fitting and the associated oil line tubing. The oil shut off valve was found in the open position, and the handle was bent, consistent with impact damage. When actuated by hand, the oil shut off valve actuated normally between the open and closed positions. Several fuel and oil lines were found impact damaged and separated. The oil drain valve was intact, and in the closed position.



**Photo 9: The engine as recovered.**

All five cylinders remained attached to the engine crankcase. Cylinder number one was intact and undamaged. The exhaust stack was separated from the exhaust shroud. Cylinder number two was intact and undamaged. The intake tube, intake and exhaust push rod tubes exhibited impact damage. The number three cylinder was intact and mostly undamaged. The intake rocker box cover was separated, and dirt/debris was found within the intake rocker box. The intake tube and exhaust were impact damaged. The intake and exhaust push rod tubes exhibited impact damage. Cylinder number four was intact and undamaged. The intake tube and exhaust were impact damaged. The exhaust pushrod tube was impact damaged. Cylinder number five was intact and undamaged. All cylinder rocker boxes exhibited internal grease around the intake and exhaust rocker arms. No evidence of any damaged springs was observed.



**Photo 10: The engine as recovered with cowling removed.**



Throttle, mixture, and carburetor heat continuity was established from the forward and aft cockpit controls to the engine. The mixture and carburetor heat cables were found separated from the rod end bearings. The areas of separation for both were consistent with impact damage. The rod end bearings for the throttle, mixture, and carburetor heat were found secure to their respective mounts. The priming system was intact and secure. The priming handle was observed in the stowed and locked position.

The forward spark plugs were removed on all five cylinders. Both the left and right magnetos were also removed. The propeller was rotated by hand and thumb compression was obtained on cylinders one, two, four, and five. All intake and exhaust rocker arms for all cylinders exhibited equal lift action. Damage to the number three cylinder intake and exhaust push rod tubes resulted in a decreased clearance for the intake and exhaust valve rocker arms (0.004 and 0.002 respectfully). Both of the intake and exhaust valve rollers would not rotate. The valve clearance adjustment nut was loosened, which allowed for further movement of the intake and exhaust valve rocker arms. The propeller was rotated by hand, and thumb compression was obtained on the number three cylinder. When the propeller was rotated, no internal binding or friction was noted within the engine and valve train.

The exhaust shroud was intact and exhibited impact damage. The aft cover was removed, and no cracks or displacement of the exhaust was observed. The exposed exhaust stacks exhibited black soot inside the stacks.

The front and rear sparkplugs, Champion REM40E's, were removed and examined. All forward spark plugs exhibited normal operational wear signatures. The forward spark plugs for cylinders one, two and three exhibited gray deposits within the electrode area, number four was oil soaked, and number five exhibited black deposits within the electrode area. The number five spark plug also exhibited a small amount of debris consistent with similar debris found outside of the cylinders. The debris was consistent with a tree that the airplane struck during the accident sequence. All five rear spark plugs exhibited normal operational wear signatures, and gray deposits within the electrode area.

The left and right magnetos were intact and undamaged. Both the left and right magnetos were installed on a magneto test bench, and produced a blue spark across all terminals when operated. The right magneto impulse coupling palls were found worn, and would not engage the impulse coupling. In addition, the P-Lead connection post was slightly loose within the magneto.

The oil sump remained intact and undamaged. The oil sump was removed and examined. The internal cavities of the oil sump contained oil, and no debris was observed.

The Holley 419 carburetor was found separated from its mounts. The mounting flange and a portion of the carburetor casing around the throttle valve/plate were separated. The dataplate for the carburetor was separated, and not located. The idle mixture control arm was found near the full lean position. The observed position of the control arm was most likely due to impact forces and damage. The throttle plate was found in the full open position. The throttle and mixture control arms moved from stop to stop when actuated by hand. All safety wire was intact and secure. The carburetor was disassembled and examined. The fuel screen was intact and free of

debris. The float bowl was free of debris, and contained no residual fuel. The metal float was intact, and free of damage. Compressed air was applied to the inlet port of the carburetor, and the float and needle valve were actuated with no anomalies noted. Solvent was poured into the float bowl, the accelerator pump was actuated, and fuel was observed expelling from the nozzle. All internal components of the carburetor appeared to be intact and undamaged.



**Photo 11: The carburetor as removed.**



**Photo 12: Carburetor float and housing.**



**Photo 13: Carburetor float bowl and housing.**



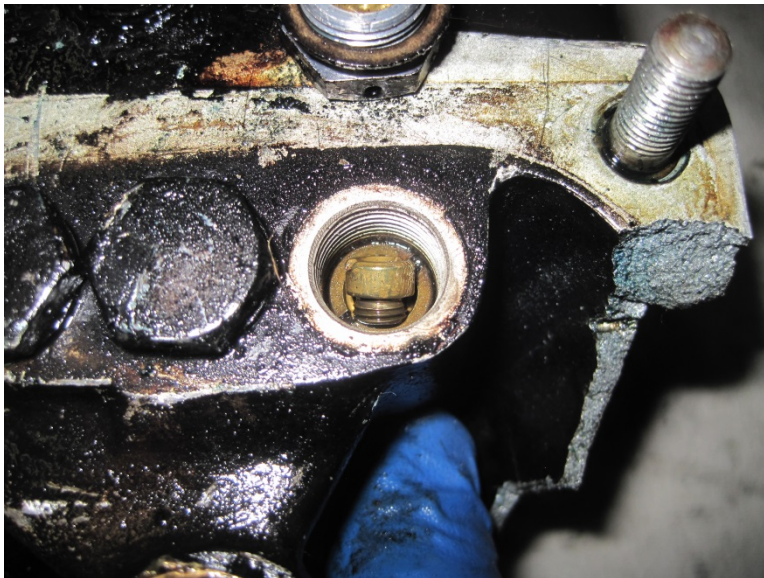
**Photo 14: Carburetor float bowl and housing.**

The main metering jet cover was removed, and the main metering jet was found unscrewed from its seat. The metering jet was observed rotated laterally about 90 degrees. The internal cap, main metering jet, and seat appeared to be bright in color and polished. Portions of the jet threads appeared to be rounded off. No gasket was observed within the main metering jet housing. In addition, no evidence of thread locking compound was observed on the threads of the fuel jet or the threads of the seat.





**Photo 15: Carburetor jet covers as found.**



**Photo 16: Main metering jet and housing after cover was removed.**

The main metering jet orifice measured 0.104 inches in diameter, and the main metering jet holder orifice measured 0.128 inches in diameter.

The power jet cover was removed, and the power jet was found in place. During removal of the power jet, it was noted that no force was needed to unscrew the jet from its seat. The jet and internal area of the cap were gray in color.

The idle circuit system was intact with no anomalies noted.

According to the Holley Aircraft Carburetors Instruction Manual for Models 419 and 429, the actual metering of the fuel is accomplished by the main metering jet, located in the passage



between the discharge nozzle and the float chamber. The metering system provides a constant mixture ratio over the cruising range of engine operating speeds.

The Sensenitch W90HASP86 wooden propeller remained attached to the crankshaft. One propeller blade was intact and undamaged. The opposing blade was separated about 5 inches outboard of the hub. The area of separation was splintered with the fracture area displaced aft.

#### **4.0 Maintenance Records Review**

Review of the airframe, powerplant, and propeller logbooks revealed that an extensive restoration of the airplane was completed May 21, 1998. An entry in the engine logbook, dated May 21, 1998, stated that the engine was overhauled and completed the date of the entry. In addition, the entry stated that a new float and gasket were installed in the Holley Carburetor, model 419, serial number 45981. The airplane was subsequently issued a standard-normal airworthiness certificate June 4, 1998.

The most recent annual was completed on March 13, 2014, at a tachometer time of 25 hours and 163.5 hours since the restoration of the airplane. The most recent maintenance and 100-hour inspection conducted on the engine was completed on March 13, 2014, at a tachometer time of 25.0 hours. The maintenance consisted of an oil change, cleaning the fuel strainer, spark plugs cleaned and tested, lubricated valves, and a compression check.

No logbook entries, supplemental type certificate (STC), or documentation was located during the investigation that provided details on when the shoulder restraints were installed in the airplane.

Further review of the Holley Aircraft Carburetors Instruction Manual for Models 419 and 429, revealed that there were no pertinent instructions regarding the installation or continued maintenance of the jet assemblies.

#### **5.0 Federal Aviation Administration Safety Belt and Seat Restraint Guidance**

Advisory Circular (AC) 43-13-1B, Acceptable Methods, Techniques, and Practices, chapter 9, section 3, part 9-46, Miscellaneous Equipment, paragraph B, states in part that "All seat belts and restraint systems must conform to standards established by the FAA. These standards are contained in Technical Standard Order (TSO) C22 for seat belts and TSO C114 for restraint systems." And that "safety belts eligible for installation in aircraft must be identified by the proper TSO markings on the belt. Each safety belt must be equipped with an approved metal to metal latching device. Airworthy type-certificated safety belts currently in aircraft may be removed for cleaning and reinstalled. However, when a TSO safety belt is found unairworthy, replacement with a new TSO-approved belt or harness is required."

AC 23-17C, Systems and Equipment Guide for Certification of Part 23 Airplanes and Airships, section 23.785 Seats, berths, litters, safety belts, and shoulder harnesses, "Methods of Approval of Retrofit Shoulder Harness Installations in Small Airplanes" states in part... "special retroactive requirements, 23.2, is also applicable. A retrofit shoulder harness installation in a small airplane may receive approval either by an STC, field approval, or as a minor change. An

STC is the most rigorous means of approval and offers the highest assurance the installation meets all the airworthiness regulations. A field approval is a suitable method of approval for a shoulder harness installation that needs little or no engineering.

The FAA does not encourage the approval of retrofit shoulder harness installations as minor changes. The preferred methods of approval are STC or field approval. However, the FAA should not forbid the approval of a retrofit shoulder harness installation as a minor change in:

- 1: The front seats of those small airplanes manufactured before July 19, 1978, and
- 2: In other seats of those small airplanes manufactured before December 13, 1986.

A retrofit shoulder harness installation may receive approval as a minor change in these small airplanes if: The installation requires no change of the structure (such as welding or drilling holes).

The certification basis of the airplane is either 14 CFR, part 23 before Amendment 23-20, part 3 of the CAR, or a predecessor regulation. In addition, a minor change installation should follow the guidance for hardware, restraint angles, and attachment locations provided in the following: AC 43.13-2B, 'Acceptable Methods, Techniques, and Practices Aircraft Alterations', AC 21-34, 'Shoulder Harness-Safety Belt Installations', and AC 23-19A, 'Airframe Guide for Certification of Part 23 Airplanes.'

Installations approved as a minor change may not provide the occupant with the protection required either by regulation (CAR 3.386) or 14 CFR, part 23, 23.561). However, a properly installed retrofit shoulder harness installation is a safety improvement over occupant restraint by seat belt alone."

AC 21-34, dated June 4, 1993, provides basic principles regarding design and installation of combined shoulder harness and safety belt restraint systems. Section 4, Installation Geometry, item D, of AC 21-34 states in part "spinal compression is likely to occur when the upper end of the shoulder belt is mounted an excessive amount below the occupant's shoulder level...the shoulder belt pulls down and back on the torso as it resists the forward motion of the occupant. The resultant restraint force...will place the spinal column in compression, and will add to the stresses in the column caused by the vertical component of the impact deceleration force.

AC 21-34, Section 7, Structural Attachments provides three design concepts that are intended to create an understanding of the features needed in the attachments.

"Concept 1: The first concept is to spread attachment loads into as much surrounding structure as possible and as gradually as possible. Gradual dissipation of loads minimizes stress concentrations at abrupt changes in material cross section which promote local failures, either immediately or upon a subsequent accident load cycle.

Concept 2: The second concept is to minimize local structural bending by attachment loads. Semimonocoque structure generally offers poor resistance to bending, but is good in tension and

shear applications. Airframe bending, buckling, or collapse adds to forward movement of the occupant.

Concept 3: The third concept is to ensure that fastener type, strength, and number are adequate in tension, shear, and bending, depending on the application. Airframe buckling under restraint loads will result in compound loading of connector plates as well as fasteners. Concurrently, material thickness is important in preventing fastener pull-out, and continued security (safety wire or equivalent) of threaded fasteners should be considered."

Item C of Section 7 states in part "...some existing aircraft will already have shoulder harness attachment points, often called "hard points," which were installed during production. As an alternative, it is fortunate to be able to attach shoulder belts to reasonably rigid structure where only a doubler may be needed to replace the material removed for fastener holes. Most often, it is necessary to attach shoulder belts to relatively thin formed sections, or even skin panels, of semimonocoque construction to achieve a satisfactory geometric configuration of the belts when in use. In most cases, attachment points need reinforcement. Attachments to welded tube and wood frame construction present a special problem in selecting the attachment point and the hardware for attachment of shoulder belts."

Submitted by: Joshua Cawthra